Physical Science: Embedded Inquiry

Conceptual Strand

Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.

Guiding Question

What tools, skills, knowledge, and dispositions are needed to conduct scientific inquiry?

Course Level Expectations	Checks for Understanding	State Performance Indicators
CLE 3202.Inq.1 Recognize that science is a progressive endeavor that reevaluates and extends what is already accepted. **CLE 3202.Inq.2** Design and conduct scientific investigations to explore new phenomena, verify previous results, test how well a theory predicts, and compare opposing theories. **CLE 3202.Inq.3** Use appropriate tools and technology to collect precise and accurate data. **CLE 3202.Inq.4** Apply qualitative and quantitative measures to analyze data and draw conclusions that are free of bias. **CLE 3202.Inq.5** Compare experimental evidence and conclusions with those drawn by others about the same testable question.	✓**3202.Inq.1** Trace the historical development of a scientific principle or theory. ✓**3202.Inq.2** Conduct scientific investigations that include testable questions, verifiable hypotheses, and appropriate variables to explore new phenomena or verify the experimental results of others. ✓**3202.Inq.3** Select appropriate tools and technology to collect precise and accurate quantitative and qualitative data. ✓**3202.Inq.4** Determine if data supports or contradicts a hypothesis or conclusion. ✓**3202.Inq.5** Compare or combine experimental evidence from two or more investigations.	**SPI 3202.Inq.1** Select a description or scenario that reevaluates and/or extends a scientific finding. **SPI 3202.Inq.2** Analyze the components of a properly designed scientific investigation. **SPI 3202.Inq.3** Determine appropriate tools to gather precise and accurate data. **SPI 3202.Inq.4** Evaluate the accuracy and precision of data. **SPI 3202.Inq.5** Defend a conclusion based on scientific evidence. **SPI 3202.Inq.6** Determine why a conclusion is free of bias. **SPI 3202.Inq.7** Compare conclusions that

CLE 3202.Inq.6 Communicate and defend scientific findings.	✓**3202.Inq.6** Recognize, analyze, and evaluate alternative explanations for the same set of observations. ✓**3202.Inq.7** Analyze experimental results and identify possible sources of experimental error. ✓**3202.Inq.8** Formulate and revise scientific explanations and models using logic and evidence.	offer different, but acceptable explanations for the same set of experimental data.

Physical Science : Embedded Technology & Engineering

Conceptual Strand

Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.

Guiding Question

How do science concepts, engineering skills, and applications of technology improve the quality of life?

Course Level Expectations	Checks for Understanding	State Performance Indicators
CLE 3202.T/E.1 Explore the impact of technology on social, political, and economic systems. **CLE 3202.T/E.2** Differentiate among elements of the engineering design cycle: design	✓**3202.T/E.1** Select appropriate tools to conduct a scientific inquiry. ✓**3202.T/E.2** Apply the engineering design process to construct a prototype that meets developmentally appropriate specifications.	**SPI 3202.T/E.1** Distinguish among tools and procedures best suited to conduct a specified scientific inquiry. **SPI 3202.T/E.2** Evaluate a protocol to determine the degree to which an engineering

constraints, model building, testing, evaluating, modifying, and retesting. **CLE 3202.T/E.3** Explain the relationship between the properties of a material and the use of the material in the application of a technology. **CLE 3202.T/E.4** Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems.	✓**3202.T/E.3** Explore how the unintended consequences of new technologies can impact human and non-human communities. ✓**3202.T/E.4** Present research on current engineering technologies that contribute to improvements in our daily lives. ✓**3202.T/E.5** Design a series of multi-view drawings that can be used by other students to construct an adaptive design and test its effectiveness.	design process was successfully applied. **SPI 3202.T/E.3** Evaluate the overall benefit to cost ratio of a new technology. **SPI 3202.T/E.4** Use design principles to determine if a new technology will improve the quality of life for an intended audience.

Physical Science : Embedded Mathematics

Conceptual Strand

Physical science applies mathematics to investigate questions, solve problems, and communicate findings.

Guiding Question

What mathematical skills and understandings are needed to successfully investigate physical science?

Course Level Expectations	Checks for Understanding	State Performance Indicators
CLE 3202.Math.1 Understand the mathematical principles behind the science of physics. **CLE 3202.Math.2** Utilize appropriate mathematical equations and processes to solve basic physics problems.	✓**3202.Math.1** Use a variety of notations appropriately (e.g. exponential, functional, square root). ✓**3202.Math.2** Select and apply an appropriate method (e.g., mental	**SPI 3202.Math.1** Use real numbers to represent real-world applications (e.g., slope, rate of change, probability, and proportionality). **SPI 3202.Math.2** Perform operations on

	mathematics, paper and pencil, or technology) for computing with real numbers, and evaluate the reasonableness of results. ✓**3202.Math.3** Apply and interpret rates of change from graphical and numerical data. ✓**3202.Math.4** Analyze graphs to describe the behavior of functions. ✓**3202.Math.5** Interpret results of algebraic procedures. ✓**3202.Math.6** Model real-world phenomena using functions and graphs. ✓**3202.Math.7** Articulate and apply algebraic properties in symbolic manipulation. ✓**3202.Math.8** Apply geometric properties, formulas, and relationships to solve real-world problems. ✓**3202.Math.9** Make decisions about units, scales, and measurement tools that are appropriate for problem situations involving measurement. ✓**3202.Math.10** Collect, represent, and describe linear and nonlinear data sets developed from the real world. ✓**3202.Math.11** Make predictions from a	algebraic expressions and informally justify the procedures chosen. **SPI 3202.Math.3** Interpret graphs that depict real-world phenomena. **SPI 3202.Math.4** Apply right triangle relationships including the Pythagorean Theorem and the distance formula. **SPI 3202.Math.5** Use concepts of length, area, and volume to estimate and solve real-world problems. **SPI 3202.Math.6** Demonstrate an understanding of rates and other derived and indirect measurements (e.g., velocity, miles per hour, revolutions per minute, cost per unit).

	linear data set using a line of best fit. ✓**3202.Math.12** 1nterpret a data set using appropriate measures of central tendency. ✓**3202.Math.13** Choose, construct, and analyze appropriate graphical representations for a data set.	

Physical Science : Standard 1 - Matter

Conceptual Strand 1

The composition and structure of matter is known, and it behaves according to principles that are generally understood.

Guiding Question 1

How does the structure of matter influence its physical and chemical behavior?

Course Level Expectations	Checks for Understanding	State Performance Indicators
CLE 3202.1.1 Explore matter in terms of its physical and chemical properties. **CLE 3202.1.2** Describe the structure and arrangement of atomic particles. **CLE 3202.1.3** Characterize and classify elements based on their atomic structure. **CLE 3202.1.4** Investigate chemical and physical	✓**3202.1.1** Distinguish among solids, liquids, gases, and plasmas. ✓**3202.1.2** Describe and illustrate the physical differences among solids, liquids, and gases in terms of their mass, volume, density, shape, and particle arrangement. ✓**3202.1.3** Use appropriate units to measure or calculate the mass and volume of	**SPI 3202.1.1** Distinguish among states of matter in terms of energy, volume, shape, particle arrangement, and phase changes. **SPI 3202.1.2** Name, measure, and describe the physical properties of substances. **SPI 3202.1.3** Compare different types of mixtures.

changes. **CLE 3202.1.5** Evaluate pure substances and mixtures. **CLE 3202.1.6** Distinguish between common ionic and covalent compounds. **CLE 3202.1.7** Construct chemical formulas for common compounds. **CLE 3202.1.8** Investigate relationships among the pressure, temperature, and volume of gases and liquids. **CLE 3202.1.9** Apply the Laws of Conservation of Mass/Energy to balance chemical equations. **CLE 3202.1.10** Distinguish among acids, bases, and neutral substances.	substances. ✓**3202.1.4** Calculate the density of substances or objects. ✓**3202.1.5** Construct and interpret a density column. ✓**3202.1.6** Identify substances as homogeneous or heterogeneous mixtures. ✓**3202.1.7** Construct an experiment to separate the components of a mixture. ✓**3202.1.8** List the three major subatomic particles and distinguish among their location, charges, and relative masses. ✓**3202.1.9** Distinguish between atomic number and atomic mass. ✓**3202.1.10** Define an isotope and describe the use of common isotopes. ✓**3202.1.11** Identify the number of protons, neutrons, and electrons in an atom of an isotope based on its atomic number and atomic mass. ✓**3202.1.12** Know the chemical symbols for the common elements. ✓**3202.1.13** Use the periodic table to	**SPI 3202.1.4** Distinguish between examples of common elements and compounds. **SPI 3202.1.5** Compare the properties of metals, metalloids, and nonmetals. **SPI 3202.1.6** Determine the composition of an atom and the characteristics of its subatomic particles. **SPI 3202.1.7** Explain the interrelationship between pressure, temperature, and volume of gases. **SPI 3202.1.8** Distinguish between physical and chemical changes in matter. **SPI 3202.1.9** Use information about an element's position in the periodic table to determine the charge of its ions. **SPI 3202.1.10** Classify chemical bonds in a compound as ionic or covalent. **SPI 3202.1.11** Construct the chemical formula of a compound using the periodic table**.** **SPI 3202.1.12** Identify the reactants and products in a chemical equation, and balance equations using proper coefficients. **SPI 3202.1.13** Predict the products of

	determine the number of protons, neutrons, and electrons in an isotope of an element. ✓**3202.1.14** Use the periodic table to identify the characteristics and properties of metals, non-metals, and metalloids. ✓**3202.1.15** Label a periodic table with oxidation numbers of main group elements, identify elements likely to form ions and use information to construct formulas for compounds. ✓**3202.1.16** Classify a substance as an element or compound based on its chemical formula or symbol. ✓**3202.1.17** Explain ionic and covalent bonding based on the oxidation numbers of the elements in a compound. ✓**3202.1.18** Investigate physical and chemical changes in a laboratory setting. ✓**3202.1.19** Balance simple chemical equations, identifying the reactants, products, and proper coefficients. ✓**3202.1.20** Predict the products of common chemical reactions. ✓**3202.1.21** Use models to represent chemical reactions as synthesis, decomposition, single-	common chemical reactions, given the reactants. **SPI 3202.1.14** Distinguish among synthesis, decomposition, single-replacement, double-replacement, and combustion reactions. **SPI 3202.1.15** Explain the Law of Conservation of Mass/Energy in terms of a balanced chemical equation. **SPI 3202.1.16** Distinguish between endothermic and exothermic reactions. **SPI 3202.1.17** Identify a substance as acidic, basic, or neutral based on its pH or response to an indicator or instrument. **SPI 3202.1.18** Recognize the effect of acid rain on the environment.

	replacement, and double-replacement. ✓**3202.1.22** Describe synthesis, decomposition, single-replacement, and double-replacement reactions using equations. ✓**3202.1.23** Describe how chemical symbols and balanced chemical equations illustrate the Law of Conservation of Mass/Energy. ✓**3202.1.24** Observe and measure temperature changes to distinguish between endothermic and exothermic reactions. ✓**3202.1.25** Conduct, analyze, and communicate the results of an experiment that demonstrates the relationship between pressure and volume of a gas. ✓**3202.1.26** Conduct, analyze, and communicate the results of an experiment that demonstrates the relationship between temperature and volume of a gas. ✓**3202.1.27** Apply indicators and instruments to classify a material as acidic, basic, or neutral. ✓**3202.1.28** Conduct research on issues associated with acid rain.	

Physical Science : Standard 2 - Energy

Conceptual Strand 2

Various forms of energy are constantly being transformed into other types without any net loss of energy from the system.

Guiding Question 2

What basic energy related ideas are essential for understanding the dependency of the natural and man-made worlds on energy?

Course Level Expectations	Checks for Understanding	State Performance Indicators
CLE 3202.2.1 Investigate the properties and behaviors of mechanical and electromagnetic waves. **CLE 3202.2.2** Explore and explain the nature of sound and light energy. **CLE 3202.2.3** Examine the applications and effects of heat energy. **CLE 3202.2.4** Probe the fundamental principles and applications of electricity. **CLE 3202.2.5** Distinguish between nuclear fission and nuclear fusion. **CLE 3202.2.6** Investigate the Law of Conservation of Energy.	✓**3202.2.1** Investigate energy transfer through waves and particles. ✓**3202.2.2** Demonstrate how waves are produced and transmitted. ✓**3202.2.3** Investigate the characteristics of light energy and sound energy. ✓**3202.2.4** Compare and contrast the four types of wave interactions. ✓**3202.2.5** Explore heat as a form of energy that may be transferred between materials. ✓**3202.2.6** Identify the boiling and freezing points of water in the Celsius, Fahrenheit, and Kelvin temperature scales.	**SPI 3202.2.1** Classify waves as transverse or longitudinal. **SPI 3202.2.2** Distinguish between mechanical and electromagnetic waves. **SPI 3202.2.3** Distinguish between wavelength, frequency, and amplitude. **SPI 3202.2.4** Identify the boiling and freezing points of water using Celsius, Fahrenheit, or Kelvin scales. **SPI 3202.2.5** Compare and contrast sound and light waves. **SPI 3202.2.6** Distinguish among wave reflection, refraction, diffraction, and

	✓**3202.2.7** Design and conduct an activity to demonstrate the conservation of heat energy during temperature changes. ✓**3202.2.8** Investigate the relationships among kinetic, potential, and total energy within a closed system. ✓**3202.2.9** Solve problems related to voltage, resistance, and current in a series circuit. ✓**3202.2.10** Investigate Ohm's law to design and build a simple circuit. ✓**3202.2.11** Research the importance of energy conservation. ✓**3202.2.12** Explore nuclear energy and its impact on science and society.	interference. **SPI 3202.2.7** Classify heat transfer as conduction, convection, or radiation. **SPI 3202.2.8** Identify a scenario that illustrates the Law of Conservation of Energy. **SPI 3202.2.9** Solve application problems related to voltage, resistance, and current in a series circuit (V=IR). **SPI 3202.2.10** Distinguish between nuclear fission and nuclear fusion. **SPI 3202.2.11** Solve problems regarding heat, mass, specific heat capacity, and temperature change (Q=mCΔT).

Physical Science : Standard 3 - Motion

Conceptual Strand 3

Objects move in ways that can be observed, described, predicted, and measured.

Guiding Question 3

What causes objects to move differently under different circumstances?

Course Level Expectations	Checks for Understanding	State Performance Indicators
CLE 3202.3.1 Investigate the relationships among speed, position, time, velocity, and acceleration. **CLE 3202.3.2** Investigate and apply Newton's three laws of motion. **CLE 3202.3.3** Examine the Law of Conservation of Momentum in real world situations.	✓**3202.3.1** Demonstrate the relationship between speed and velocity. ✓**3202.3.2** Create models that represent Newton's three laws of motion. ✓**3202.3.3** Evaluate scenarios that illustrate Newton's three laws of motion. ✓**3202.3.4** Investigate the Law of Conservation of Momentum. ✓**3202.3.5** Research the historical development of the laws of motion. ✓**3202.3.6** Collect data to construct, analyze, and interpret graphs for experiments that involve distance, speed, velocity, and time. ✓**3202.3.7** Solve problems related to velocity, acceleration, force, work, and power.	**SPI 3202.3.1** Distinguish between speed and velocity. **SPI 3202.3.2** Relate inertia, force, or action-reaction forces to Newton's three laws of motion. **SPI 3202.3.3** Distinguish among the concepts inherent in Newton's three laws of motion. **SPI 3202.3.4** Interpret a position-time graph for velocity or a velocity-time graph for acceleration. **SPI 3202.3.5** Solve application problems related to velocity, acceleration, force, work, and power using appropriate units of measurement (v=d/t, a=Δv/t, F=ma, W=Fd, and P=W/t). **SPI 3202.3.6** Choose a correct representation of the Law of Conservation of Momentum.

Physical Science : Standard 4 – Forces In Nature

Conceptual Strand 4

Everything in the universe exerts a gravitational force on everything else; there is interplay between magnetic fields and electrical currents.

Guiding Question 4

What are the scientific principles that explain gravity and electromagnetism?

Course Level Expectations	Checks for Understanding	State Performance Indicators
CLE 3202.4.1 Explore the difference between mass and weight. **CLE 3202.4.2** Relate gravitational force to mass. **CLE 3202.4.3** Demonstrate the relationships among work, power, and machines.	✓**3202.4.1** Demonstrate the effect of gravity on objects. ✓**3202.4.2** Explore the difference between mass and weight. ✓**3202.4.3** Design, demonstrate, and explain simple and compound machines. ✓**3202.4.4** Gather and analyze data and solve problems related to mechanical advantage and efficiency of simple machines.	**SPI 3202.4.1** Distinguish between mass and weight using SI units. **SPI 3202.4.2** Identify the effects of gravitational force on a falling body or satellite. **SPI 3202.4.3** Identify various types of simple machines. **SPI 3202.4.4** Recognize the simple machines found in a compound machine. **SPI 3202.4.5** Solve application problems related to mechanical advantage and the efficiency of simple machines, given appropriate equations (MA=FO/FI and Eff=WO/WI).